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(54) PRESSURE CONTROL VALVE

(71) We, FUJI ELECTRIC CO., LTD., a Japanese Company, of No. 1-1, Tanabeshinden, Kawasaki-ku, Kawasaki-shi, Kanagawa, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a pressure control valve capable of controlling the pressures of two gas systems simultaneously and to an equal value.

The need to control the pressures of two gas systems simultaneously and to an equal value and to control automatically the pressure of one gas system in accordance with the change of the pressure of another gas system is often felt in various industrial spheres.

Particularly, in a fuel cell, e.g., a hydrogen-oxygen type fuel cell, comprising a generator cell having a fuel gas chamber, an oxidizing gas chamber and an electrolyzing solution chamber, a fuel gas circulating circuit and an oxidizing gas circulating circuit for supplying the fuel gas and the oxidizing gas to the fuel gas chamber and the oxidizing gas of said generator cell, there is a necessity to balance the pressure of hydrogen or oxygen gas with that of the electrolytic solution thereby to prevent the blowing of the gas into the electrolyzing solution chamber or to prevent the penetration of the electrolytic solution into the gas chamber, for the purpose of keeping said three phase zones separate from one another. If the pressure balance between the gas solution is destroyed, each gas blows through the gas chamber into the electrolyzing solution chamber, or the electrolytic solution penetrates through the electrolyzing solution chamber into the gas chamber, thus making it impossible to keep the three phase zones separate.

In order to satisfy such a requirement, each of the gas systems is provided with a pair of separate pressure controllers thereby to adjust the pressures of gas systems to the same value.

In such a case, however, a pressure difference may be caused between both said gas systems during the pressure controlling period, and besides, the pressure difference may also be caused even after adjusting both said pressures to the same value because of aging of the pressure control springs and because of differences between the properties of the springs.

Accordingly, with the usual pressure controlling device it is impossible to control the pressure of the gas systems stably and for a long period of time.

Therefore, this invention is intended to provide a pressure controlling apparatus capable of controlling the pressures of two gas systems simultaneously and to the equal value.

According to the present invention there is provided an apparatus for regulating the pressure of hydrogen gas and oxygen gas in a fuel cell comprising a pressure controlling spring chamber formed by a pair of spaced diaphragms at the middle part of a casing, a spring contained in said spring chamber and uniformly biasing both said diaphragms, a pair of valves arranged symmetrically at both sides of the spring chamber in order to open or close gas flow openings for hydrogen gas and oxygen gas respectively, a hydrogen gas system and an oxygen gas system connected to the hydrogen gas flow opening and the oxygen gas flow opening respectively, a pair of pressure feed back chambers provided at both sides of the pressure controlling spring chambers and connected to derive a pressure corresponding the internal pressure of each of said gas systems, valve rods connected to said valves, one end of each of which rods engages with one of said diaphragms, and a sealing spring biasing each of said valves towards the valve closing direction.

The invention is illustrated by way of example in the accompanying drawings, in which:—

Figure 1 is a systematic view of a fuel cell having the pressure regulating means according to this invention,

Figure 2 is a longitudinal cross section of the pressure controller means shown in Figure 1, and

Figure 3 is a partly enlarged cross section of another pressure controller means shown in Figure 1.

Figure 1 shows a schematic view of a fuel cell provided with a pressure controller means 50 in order to keep a balance between the hydrogen or oxygen gas pressure and the electrolytic solution pressure. In Figure 1, the fuel cell 1 is shown as composed of an oxygen gas chamber 18, a hydrogen gas chamber 19, an electrolyzing solution chamber 20, a hydrogen electrode 21, and an oxygen electrode 22. A hydrogen gas circulating system 51 and an oxygen gas circulating system 52 are arranged mutually symmetrically. The high pressure hydrogen and oxygen gases are reduced in pressure by a pressure controller means 50 described below, supplied to the gas chambers 18 and 19 of the generating cell *via* ejectors 53 and 54, and consumed therein in an amount corresponding to the electrical power generated. In such a case, both the pressure in the oxygen gas chamber 18 and that in the hydrogen gas chamber 19 are required to be kept at constant and equal values corresponding to the electrical power generated. The pressure controlling means 50 is constructed to satisfy such requirements as shown in Figure 2 and Figure 3. In Figure 2, numerals 51 and 52 indicate the hydrogen gas consuming system and oxygen gas consuming system, respectively, and numerals 55 and 56 indicate the hydrogen gas supplying system and the oxygen gas supplying system, respectively. The pressure controlling means 50 is provided between both said gas consuming systems 51 and 52 and both said gas supplying systems 55 and 56, and is constructed to control both pressures simultaneously. That is to say, a pressure controlling spring chamber 63 formed by a pair of diaphragms 62 and 62' is provided on a middle part of a hollow casing 61, and a pressure controlling spring 64 is contained in said chamber 63. A pair of pressure controlling valve mechanisms for the gas consuming systems 51 and 52 is symmetrically provided at both sides of the pressure controlling spring chamber 63.

One of the pressure controlling valve mechanisms will be described. Numeral 65 indicates a gas inlet connected to the gas supplying system 55, and numeral 66 indicates a gas outlet connected to the gas consuming system 51. A valve 67 opens or closes an outlet opening 68 which communicates with the gas inlet 65 and the gas outlet 66. The valve 67 is attached on a valve rod 69 which always engages with the diaphragm 62, and is always biased towards the valve seat of the outlet opeing 68 by a sealing spring 70. A pair of pressure feed back chambers 71, 71' is provided at both sides of the pressure controlling spring chamber 63, and the pressure of the gas consuming system 51 is communicated to the feed back chamber 71 *via* an opening 72. An O ring 73 provides a seal between the gas outlet 66 and the pressure feed back chamber 71, and an O ring 74 seals the gas inlet 65 from the atmosphere. The other pressure controlling valve mechanism for between the other gas supply system 56 and the system 52 is constructed in the same way as already described and is indicated with the same reference numerals having reference indices. Numeral 75 indicates holes for introducing atmospheric pressure or other suitable pressure to the pressure controlling spring chamber 63.

The pressure controlling valve means 50 thus formed is operated as described below. Gases supplied from the gas supplying systems 55 and 56 flow through the gas inlets 65, 65', respectively, into the casing 61, and, when the valves 67, 67' are opened, are supplied through the opening 68 and the gas outlets 66, 66' to the gas consuming systems 51, 52, respectively. The pressures in the gas consuming systems 51 and 52 change with the amount of gas supplied, but are introduced into the pressure feed back chambers 71 and 71' and controlled therein in a manner hereinafter described.

If neglecting the friction forces of the O rings 73, 74, 73', 74' and diaphragms 62, 62', as the diameter of the O ring 73 or 74 is equal to that of the O ring 73' or 74' to offset the thrust of the gas supplying side with that of the gas consuming side, the force compressing the valve rod 69, 69' toward the sealing spring 70, 70' is the sum of a force caused by multiplying the inner pressure of the pressure controlling spring chamber 63 by the effective area of the diaphragm 72, 72' and the repelling force of the pressure controlling spring 64. On the other hand, the inverse force is the sum of a force caused by multiplying the inner pressure of the pressure feed back chamber 72 by the effective area of the diaphragm 72, 72' and the repelling forces of the sealing springs 70, 70'. The difference between both said forces serves as a force to thrust the valve rod 69 towards the sealing spring 70, i.e. a force to open the valve 67. Accordingly, the pressure in the gas consuming system is determined by the

force which actuates the valve rod, or the repelling force of the pressure controlling spring 64. According to the pressure controlling mechanism of this invention, a pair of presssure controlling means, each having the same size and structure, is arranged symmetrically and a single pressure controlling spring means is used to provide the repelling force on the diaphragms of both gas systems. Thus the pressures in the two gas consuming systems are controlled to equal value by the pressure controlling mechanism in a simple manner.

In order to control the pressure of the gas consuming system, the repelling force of the pressure controlling spring may be made adjustable, as shown in Figure 3.

Figure 3 shows the construction of the pressure controlling spring chamber 63 in Figure 2, in which a means for adjusting the preset pressure by changing the compressed length of the spring is provided.

The repelling force of the spring will be changed in accordance with the compressed length of the spring. The pressure controlling spring 64 in this example is composed of two springs 64a and 64b, and the former spring 64b is provided between the diaphragm 62 and a spring seat 77, and the latter spring 64b is provided between the other diaphragm 62 and a spring seat 78. Each of said spring seats 77, 78 is supported so as to move axially along guide pins 79, 80, respectively. A repelling force adjusting means 81 has a bolt portion 82 screwed into one of the spring seats 77, a bolt portion 83 screwed inversely into the other spring seat 78, and a flange like dial 84 at the middle part. A handling opening 85 is provided on the casing 61 and usually closed by the lid 86. The guide pins 79, 80 are attached to the valve casing 61.

When the repelling forces of the pressure controlling spring 64a, 64b are required to be changed, the dial 84 may be manually rotated to shift the valve seats 77, 78 axially and relatively to one another as the rotation thereof is prevented by the guide pins 79, 80. Thus, the repelling forces of the pressure controlling springs 64a, 64b can be changed.

As particularly described above, according to the single pressure adjusting valve means, the pressures of the hydrogen gas and oxygen gas systems can be adjusted to equal value, and also set easily and simultaneously to a desired value.

While this invention has been described with reference to particular embodiments thereof, it will be understood that numerous modifications may be made by those skilled in the art without actually departing from the scope of the invention as defined by the appended claims.

WHAT WE CLAIM IS:—

1. An apparatus for regulating the pressure of hydrogen gas and oxygen gas in a fuel cell comprising a pressure controlling spring chamber formed by a pair of spaced diaphragms at the middle part of a casing, a spring contained in said spring chamber and uniformly biasing both said diaphragms, a pair of valves arranged symmetrically at both sides of the spring chamber in order to open or close gas flow openings for hydrogen gas and oxygen gas respectively, a hydrogen gas system and an oxygen gas system connected to the hydrogen gas flow opening and the oxygen gas flow opening respectively, a pair of pressure feed back chambers provided at both sides of the pressure controlling spring chambers and connected to derive a pressure corresponding to the internal pressure of each of said gas systems, valve rods connected to said valves, one end of each of which rods engages with one of said diaphragms, and a sealing spring biasing each of said valves towards the valve closing direction.

2. An apparatus substantially as hereinbefore described with reference to Figures 1 and 2 or as modified by Figure 3 of the accompanying drawings.

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1 SHEET This drawing is a reproduction of the Original on a reduced scale

FIG. 1

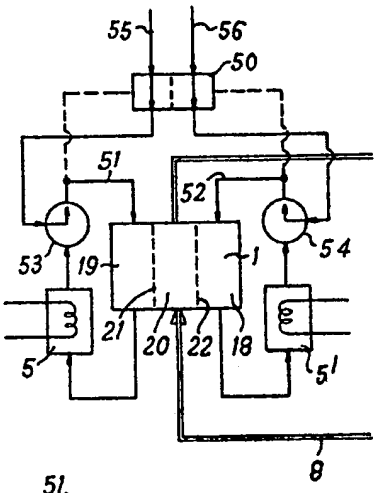

FIG. 2

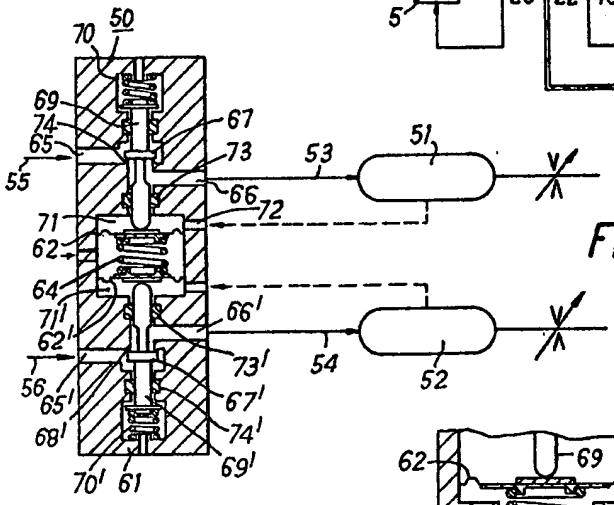

FIG. 3